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WASTE MATERIALS TO BIOFUEL USING MICROORGANISMS

Dr. Krishna

Assistant Professor in Biotechnology, Tumkur University, Tumakuru, Karnataka, (India)

ABSTRACT

Biofuels are the bio product, produced by microorganisms by fermentation. It can be produced by using varies types of wastes available in earth environment. Biofuels must be the alternate for fuels in future. Fuel scarcity now a day is the biggest war issue product. To overcome from such social problems researchers must dedicate their work to produce biofuel from waste materials. So that both problems – demand for fuels and management of wastes will be solved. So in the concern of good earth life present chapter will discuss about use of waste materials to produce biofuels by using microorganisms. Biofuels are produced by fermentation techniques. In scientific field there are many types of fermentation techniques to produce biofuels. But in this chapter we discus about simple conventional and low cost technique to produce biofuel, that can be used even by common person. To achieve this, in the present work *Solanumnigrum* L. fruits were taken, which is the weed found all over the country. According to literature *Solanumnigrum* is the best medicinal plant and used very commonly in Asian counties. But use of *Solanumnigrum* L. fruits for biofuel is not yet recorded. Both spoiled and fresh fruits were used as substrate and achieved production of bioethanol using *Saccharomyces cerevisiae*. According to literatures about fermentation many wastes like agro wastes, fruit wastes and many more can be used to produce biofuel.

Keywords: Biofuels, Microorganisms, Wastes

I.INTRODUCTION

In earth fuels are of two categories, one is geographical fuel, that is fuel from fossil fuels from prehistoric biological matter and second is biofuels, derived directly from plants and indirectly from agricultural, industrial, commercial and domestic waste substrates. All these substrates are generally known as biomass. Conversion of biomass results in fuel in solid, liquid, and gas form. Such biofuels are renewable fuels which generally involve contemporary carbon fixation, same that occur during photosynthetic bacteria. There are different types of wastes or biomass. Some of the biofuels are like bioethanol, biomethanol, biodiesel, butanol, green diesel, biogasoline, vegetable oils, bioethers, biogas, syngas, solid biomass fuels and these are categories in different biofuels generations like, First, second, third and fourth generation biofuels.

Fossil fuels such as crude oil, coal and natural gas – power cars and generate heat and electricity. Fossil fuels are a finite resource as they take millions of years to form and the remaining supplies are being used at a greater rate

than can be sustained. When burnt, fossil fuels release carbon dioxide into the atmosphere. This stored form of carbon is released, increasing atmospheric carbon dioxide, adding to greenhouse gases and contributing to climate change.

Biofuels are an integral part of the emerging 'bio-economy', where plant material is used to produce specific chemicals and bulk industrial chemicals. In the future these may increasingly replace chemicals derived from fossil oil. The full picture, however, is much more complex as different biofuels have widely differing environmental, social and economic impacts. Biofuels are already entering the market, driven amongst other things by their potential to improve energy security and to contribute to climate change mitigation. There are real opportunities to develop efficient biofuel supply chains that can deliver substantial greenhouse gas savings [20].

Transport now accounts for about 20% of global anthropogenic carbon dioxide emissions and 25% of emissions in the United Kingdom (UK), and these figures are growing faster than for any other sector. If the UK is to reach its target of reducing emissions by 60% by 2050 then cuts will need to be made in the transport sector. Transport has become the main driver for increasing global primary oil demand, which is predicted to grow by 1.3% per year up to 2030, reaching 116 million barrels per day (up from 84 million barrels per day in 2005) [20].

Deterioration of the environment due to rapid industrialization of human production and dependence of countries on imported fossil fuels has meant that satisfaction of their energy needs is not assured. These considerations made the discovery of renewable fuels, which will be based on national resources - one of the most important priorities for most countries worldwide [5-7]. The use of wastes as raw materials for the production of biofuels not only prevents the "food *versus* fuel" dilemma; it also counteracts accumulation of these wastes in the environment.

Food waste is an interesting potential substrate, as the amount of it in the EU is growing. According to a report released by the European Commission in 2010, it has been estimated to increase from 89.3 Mt in 2006 (which resulted in the emission of 170 million tons of CO2) to 126.2 Mt by 2020 [12]. Food waste can be derived from homes, manufacturing, food services, and the retail sector; domestic food waste production is the largest part of them and accounts for 42% of the total. The problem of food waste production is higher in Asia, where an increase in the total amount of annual urban food waste is expected from 278 Mt in 2005 to 416 Mt in 2025 [13].

The disposal of large amounts of wastes can be a challenge, and cause severe environmental issues when used in landfill sites, such as uncontrolled gas emissions that contribute to the greenhouse effect, and contamination of water underground [14,15]. It has been estimated that approximately 125 m^3 of gas is produced from each ton of food waste that is used for landfill, with an average composition of 60%–65% methane and 35%–40% CO2, which is responsible for 8% of the total anthropogenic methane emissions [16]. In many Asian countries, landfill and open dumping of food waste represent a large proportion of waste treatment methods [17]. Other practices of food waste utilization, such as feeding animals, have raised serious hygiene-related issues and the use of them as fertilizers can cause severe pollution of water [18, 19].

Moreover, in recent years' regulations about feeding animals with food waste have become stricter. For example, in the EU, the EC law no. 1774/2002 prohibits the use of catering waste for animal feed [9]. Finally, incineration is also a waste treatment method used for food waste. Despite the fact that energy can be produced during incineration, the capital and operating costs are considered to be too high and air pollution can also result *(For example, see* [13]). It is obvious that these "traditional" ways of food waste manipulation have proven to be problematic from an environmental point of view and do not help in reducing their total amount. These food wastes or any other waste if accumulate in large amount, then management is in future is very difficult. In order to overcome with the types of problem, we consider production of biofuel is alternate management for wastes.

Bioethanol one of the best and more extensively used biofuel from past to present day. In future demand for bioethanol definitely increases as the geographical fuels decreases. The decrease of geographical fuels is mainly due to development and population blast day by day, indirectly result in increase in wastes in earth. The better solution for both is the production of biofuels by using microorganisms. Exploit of microorganisms in the field of biofuel production is very less, say about 1 to 2% from total number of microorganisms known till now. Current research in biofuel production using microorganisms are slowly gaining attention, but require more research on production of biofuels. Finding suitable biomass and microorganisms is a task to overcome from increased demand on geographical fuels. Finding new methodology to use wastes as a substrate and finding more suitable crops and microorganisms are the major steps to achieve the target product. Knowledge on biofuels is essential to fulfill the energy demand.

Some of the microorganisms such as yeast – includes *Saccharomyces cerevisiae*, species of *Saccharomyces*, fungi – includes *Cunninghamella japonica* and *Gliocladiumroseum* are the recent research promise to produce lipids and myco-deisel, bacteria – includes animal gut bacteria like *Clostridium* found in Zebra feces, convert cellulose into butanol fuel. Microbes in panda waste are used for production of biofuel from bamboo and other materials. Algae – includes Diatoms and other algal species are used as biomass to produce biofuels. In the present chapter, discussing about plant biomass – plant weed *Solanumnigrum*. L. fruit, a weed found all over the world. In the view of farmer benefit present *Solanumnigrum* plant fruit was used as a substrate for the production of bioethanol using screened microorganisms.

Selected biomass will be from non-economical to economical plant in agricultural field. Fruits of *Solanumnigrum* contains new type of polysaccharide which was discovered recently and fermentation or degradation of *Solanumnigrum* L. fruit was fast compare to other fruits by using *Saccharomyces cerevisiae*. Screening methods and fermentation techniques used are simple and conventional. And achieve 8.6% of bioethanol. But still more research requires for such work to know the best suitable microorganisms and fermentation condition. Upgradation of methods may be achieved by using genetic engineering and molecular biology methods. Through by inserting suitable insert gene to screened microorganisms to get high percentage of bioethanol with suitable environmental management. In management of wastes, use of waste material is very much helpful. Because it is very cheap, contains rich amount of carbohydrates (in case of agricultural wastes), easy to obtained and remediation of waste material will get alternate solution with byproduct such as biofuel.

Ethanol is an excellent candidate to replace gasoline, and it has traditionally been produced mainly from sugars

or starch [8, 9]. The use of sugars and starch as raw materials for ethanol production had a negative effect on their availability as human food, which raised their prices globally and increased concern about the ethics of biofuel production [9-11]. In the present work the weed plant *Solanumnigrum*L. fruits are used, which is commonly available in agricultural fields. Many researchers recorded that the plant have many medicinal properties, which is commonly used as traditional medicine in India. The use of its fruits for the production of alcohol is not yet explored. So in the view of agriculture as well as human being the present work was undertaken.

II.SOLANUM NIGRUM L. FRUIT TO BIOETHANOL

Bioethanol is one of the best alternate fuel for present and future use. Bioethanol is a type of biofuel, and is defined as any fuel whose energy obtained through biological process. The production of bioethanol is mainly involved in use of microorganisms in the absence of oxygen, calledanaerobic fermentation [1, 3]. It can be produced from materials which have carbohydrate sources. The carbohydrate sources can be used directly as starch, sucrose, glucose etc. or it may be in natural sources like in plant material such as fruits, grains (rice, barley, wheat etc.) or in other waste materials which contains rich amount of carbohydrates such as waste from agriculture, industries and domestic [2, 4]. In management of wastes, use of waste material is very much helpful [1]. Because it is very cheap, contains rich amount of carbohydrates (in case of agricultural wastes), easy to obtained and remediation of waste material will get alternate solution with by-product such as biofuel [2].

Production of Bioethanol from *SolanumNigrum* L. Fruit was achieved in different steps, firstly by selection of Microorganisms for Bioethanol Production. The selection of microorganisms is very important in fermentation process. Because when it is subject to different levels of experiments, it should not under go any changes like mutation. In this work the microorganisms are selected from spoiled fruits of *S. nigrum* by using suitable media. When the microorganisms are isolated in suitable media are then purified and subjected to selected substrate. In the present work there are mainly two microorganisms were isolated and are belongs to *Saccharomyces* sp.

In second step, selection of substrate for the production of bioethanol. The main substrate used in this process is fruits of *S. nigrum* L. plants with sugar. Along with this the spoiled fruits such as grapes, banana and apple are used for the production of biofuel. The selected substrate where first subject to surface sterilization with sodium hypochlorite. The with distilled water and processed for fermentation. Experimental Setup for the production of Bioethanol was set in two levels for the first time, this novel method is to get high percentage of alcohol.

Level 1: In this level both the microorganisms which was isolated from suitable media is subjected to substrate with defined concentration, pH and temperature. The substrate is *S. nigrum* L. fruit alone with sugar in three sets, one set is for *Saccharomyces cerevisiae*, one for *Saccharomyces*sp and one more is for unidentified microorganism. Level 2: Here again both microorganisms are used along with *S. cerevisiae*, but instead of single substrate mixture of spoiled fruits are used and kept for fermentation process. In third step, selected different fermentation condition for Level 1 and Level 2 [Table 1].

In fourth step, recovery of bioethanol after 18 days of anaerobic fermentation the bioethanol was recovered by using simple filtration technique [1]. Then the product obtained is in crude form, that means it contains other

volatile compounds. In order to get pure form, the product is subjected to alcohol distillation process (novel distillation setup was designed). The percentage of alcohol recovered is estimated by using specific gravity method [1, 2] and obtained specific gravity is compared with AOAC chart [2].The percentage of bioethanol from *Solanumnigrum.* L. fruits were tabulated in [Table 2].

This work was for the first time used *Solanumnigrum* L. fruits as substrate for the production bioethanol and it will have good future for agriculturist as well as for industrialist. The percentage of distilled bioethanol is determined by using pycnometer. The percentage was obtained by using standard chart AOAC against density of alcohol at 20^0C. In Figure 1 it was clear that the level 1 with set1 produced high amount of bioethanol when compared to other set and level. In the present study it was observed that Level 1 recorded high percentage of bioethanol compared to Level 2. So it suggests that use of single substrate with sugar yield high percentage of bioethanol, compared to mixed fruits, and *Solanumnigrum* L. fruits.

III.FIGURES AND TABLES

Table 1. Different levels of experiments for the production of bioethanol

Levels	**Production of Bioethanol**		
	Parameters	***Optimum Conditions***	***Inoculum***
Level 1	**Substrate:** *S. nigrum* Fruit Sugar	 100g/l 25g/l	Set1[a] Set2[b] Set3[c]
	pH	3-4	
	Temperature	30^0C	
Level 2	**Substrate:** *S. nigrum* Fruit Sugar Mixed spoiled Fruits	 100g/l 25g/l 50g/l	Set1[a] Set2[b] Set3[c]
	pH	3-4	
	Temperature	30^0C	

Set1[a] – Inoculation of *Saccharomyces cerevisiae,* Set2[b] – Inoculation of *Saccharomyces*sp

Set3[c] – Inoculation of Unidentified Microorganism

Note: g = gram, l = liter, ^{0}C = degree Celsius, % = percentage

Table 2. Percentage of bioethanol produced by different sets of microorganisms

Levels	Production of Bioethanol at 20^0C		
	Inoculum	***Density***	***Percentage***
Level 1	Set1[a]	0.98389	8.6%
	Set2[b]	0.98404	8.5%
	Set3[c]	0.98434	8.3%
Level2	Set1[a]	0.98971	4.8%
	Set2[b]	0.99053	4.3%
	Set3[c]	0.99137	3.8%

Set1[a] – Inoculation of *Saccharomyces cerevisiae,* Set2[b] – Inoculation of *Saccharomyces*sp

Set3[c] – Inoculation of Unidentified Microorganism

Note: Density in kg/L (Kilogram per Liter), % = percentage, ^{0}C = degree Celsius

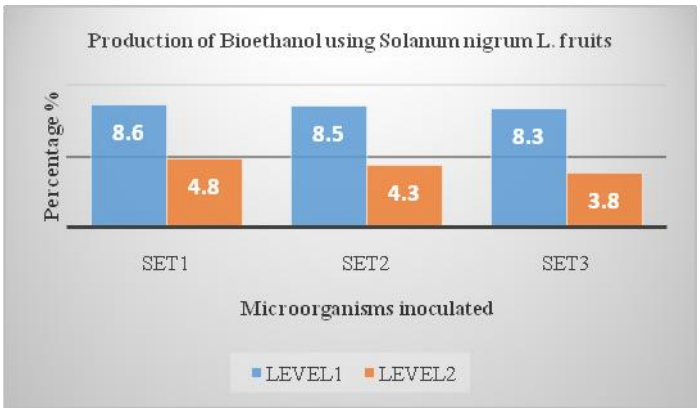

Figure 1. Histogram of production of bioethanol in percentage.

IV.CONCLUSION

In present and future, for transport, lighting, power and heating biofuels are the alternate to geographical fuels. Crops with sugar and oil are used as bioethanol and biodiesel. Agricultural, industrial, commercial and domestic wastes are good source for biofuel production. Use of wastes helpful in management of wastes from earth environment. High carbohydrates or sugars yield more percentage of bioethanol. Exploit of newly identified polysaccharides for bioethanol production is essential, because these polysaccharides may produce more percentage of bioethanol compare to already known sugars or carbohydrates. Use of more microorganisms on biomass is essential to get suitable microorganisms to increase the biofuel production and achieve increased demand for biofuel. Biofuel may help to promote agricultural development; some biofuels may help reduce greenhouse gas emission. But biofuels may threaten to land, water and biodiversity. So proper management of

biofuels is must and guidelines should be implicated to use biomass and production of biofuels to help to achieve energy securities and good environment on earth.

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